

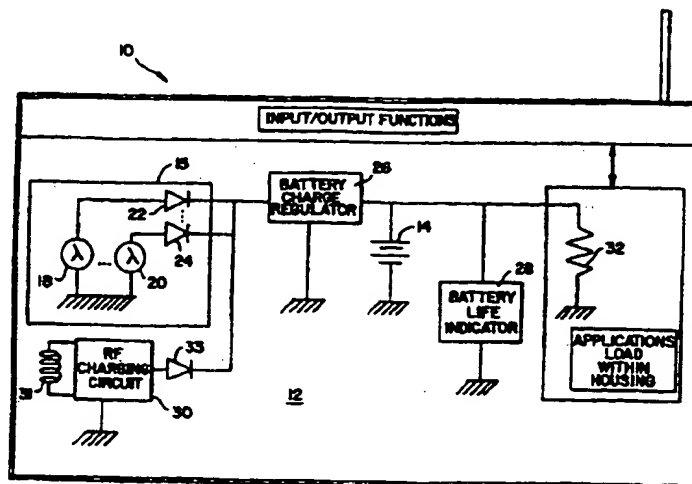
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(54) Title: INTEGRATED POWER SOURCE



(57) Abstract

A self-contained, small, lightweight, portable, renewable, modular integrated power source (10). The power source consists of solar cells (18, 20) that are laminated onto a solid state polymer battery (12) which in turn is laminated onto a substrate containing circuits (26) which manage the polymer battery charging. Charging of the battery can occur via solar energy or, alternatively, via RF coupling using external RF charging equipment (30) or a hand held generator. For added support, the integrated power source is then bonded to an applications housing or structure. This integrated power source can independently power the electronic application. It can also serve as casing or housing by taking the shape of the application enclosure.

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INTEGRATED POWER SOURCE

STATEMENT OF GOVERNMENTAL INTEREST

The Government has rights in this invention pursuant to Contract No. FA8002-96-C-0301 awarded by the Department of the Air Force.

BACKGROUND OF THE INVENTIONField of the Invention

The present invention relates to power supplies and, particularly, to a small, lightweight, portable, rechargeable and modular integrated power source of the solar cell variety.

Description of the Prior Art

With the ever expanding use of the conventional battery in many types of equipment which rely on batteries for electrical power, the advantages of a portable, renewable, self-contained power source which is integrated within applications are self-evident, especially if during actual delivery of current the changing of depleted battery cells is eliminated. A power-on-demand capability, where maintenance can be held to a minimum, is extremely attractive when supplying power to emergency communication equipment. Never having to replace batteries, for example, in walkie-talkie radios, modular cellular telephones, pagers, radios, data recording devices and other hand-held portable equipment, offers money-saving operations and consequently a lower cost. With the advent of environmentally friendly, form malleable polymer battery, technology now exists to design and develop self-contained, energy-renewable power sources for all types of portable applications.

One prior art power source battery is disclosed in U.S. Patent No. 3,005,862 wherein a solar battery can have its elements shaped or curved to desired configurations. In one embodiment, the solar panel itself can form a wall of a satellite. The preferred material of which the panelling is made is aluminum, although other materials such as stainless steel, beryllium, magnesium, or titanium, or even plastic may

be reduced to its essential elements. Patent No. '862 merely demonstrates another way for mounting a solar battery.

U.S. Patent No. 5,180,645 carries the principles of Patent No. '862 one step further by recognizing the importance of providing an integrated battery into or part of an equipment housing. Patent No. '645 is primarily directed, however, to a battery formed of first and second current collectors separated by a solid state electrolyte. Fig. 2 of Patent '645 shows such a battery embedded in a radio housing with the traditional role of the housing as a separate element intact.

SUMMARY OF THE INVENTION

In accordance with the invention of a self-contained, energy renewable power source, recent advances in technology have centered on the following achievements:

1. Improved performance and stability of polymer anode and cathode materials such as polypyrrole through improved electrolytic drying procedures and processing conditions.
2. Incorporated solid polymer electrolytes in prototype all-polymer batteries and modified solvents used in preparation of electrolytes such as polyacrylonitrile to achieve improved electrolyte performance.
3. Expanded class of solids used as polymer anodes and cathodes to include promising candidate materials including redox-couple substituted thiophenes to achieve higher cell potentials and stability.

The recent developments, moreover, in polymer batteries now provide a technology in which a battery can be integrated within the mechanical supporting structure for an application circuit. No longer will conventional restraints require a battery as a separate add-on component thereby dispensing with the need for a separate battery compartment and the cables historically necessary to connect the power source to the electronic components. The invention further considers the development of a novel and unique integration of a polymer battery coupled with miniaturized integrated electronics. With the ability to take on a shape malleable to a particular

application, an environmentally friendly polymer battery can potentially incorporate solar cells, SRAMS, DRAMS and IC's to provide power source and nonvolatile memory data collection and storage. In one preferred application, solar cells backed with
5 a thin film polymer battery at the component level can supply a self-contained, lightweight, and fully integrated power source. Beyond the chip level, polymer batteries can be incorporated into devices as the mechanical backing and structures for multi-layer printed circuit board technology. In its most
10 general sense, the nature of polymer battery technology is such that a chassis or housing can be molded into a desired shape using the battery material itself and still incorporate a power source for the intended application.

Accordingly, an object of the invention is to assemble a
15 polymer battery as the structural casing of an electronic unit so that interconnecting wires between the battery, a charging unit, and a regulating circuit are eliminated.

Another object of the invention is a power source consisting of solar cells, RF charging unit or microwave energy
20 charging means which are integrated structurally with a polymer battery.

Yet another object of the invention is the integration of a polymer battery as the principal structural element in the formation of a solar-powered electronic unit.

25 A further object of the invention is an implementation for integrated power management electronics offering voltage regulation, under/over voltage control, under/over current control and polymer battery charging control utilizing polymer and other semiconductor circuitry.

30 Still another object of the invention is an integrated power source stacked on top of the integrated power management circuit layer which incorporate additional applications circuitry such as SRAM (static random access memory), DRAM's (dynamic random access memory) for data storage purposes.

35 Yet another object of the invention is to laminate an integrated applications electronics layer onto the integrated power source thereby implementing miniaturization beyond the

volumetric reduction gained by housing an applications board within an integrated power source enclosure.

5 Another object is a power source which combines on a layered p or n- doped polymer substrate resistive, capacitive components, semiconductors laminate layer on to another layer consisting of the solid polymer battery, all integrated onto a base material to provide a structural shell for an electronics unit.

10 Other objects and advantages of the invention will become apparent to those skilled in the art in the course of the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows one form of the integrated power source embodying the invention.

15 Fig. 2 shows the integrated power source of Fig. 1 but depicting the individual laminations and their structural relationship to each other.

20 Fig. 3(a)-3(d) shows the integrated power source of the invention as applied to a conventional cordless telephone system.

Fig. 4 shows an application of the integrated power source of the invention to a vehicle such as a passenger automobile.

Fig. 5 shows an application of the integrated power source of the invention to a lap top computer.

25 Figs. 6, 7 and 8 show, respectively, applications of the integrated power source of the invention to an emergency sun shield message communication wireless panel, a residential or commercial structure such as a building or the like, and highway signs.

30 Fig. 9 is a sectional view taken along the lines IX-IX of Fig. 8, both signs pictured being represented.

Fig. 10 is a block diagram of a circuit which carries out the operation of the integrated power source of the invention.

35 Fig. 11 is a cross section of multiple laminations showing an alternate embodiment of the integrated power source of the invention.

The same reference characters refer to the same elements throughout the several views.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Fig. 1, an integrated power source is indicated generally by the reference numeral 10 and includes as one of its components an essentially flat, planar and malleable polymer battery 12 which offers structural support for a plurality of electronic components of eclectic choice. Battery 12 may be any one of a number of solid state polymer batteries which have existed in the art for several years. One type of polymer battery believed to be appropriate for use in connection with the device illustrated in Fig. 1 is described and claimed in U.S. Patent application Serial No. _____ entitled "A Completely Polymeric Charge Storage Device and Method for Producing Same", filed _____, and assigned to the assignee of the instant application. It will thus be understood that battery 12 will comprise in a preferred form an ionically conducting gel polymer electrolyte layer separating opposing surfaces of electronically conducting conjugated polymeric anode and cathode elements supported on a lightweight porous substrate. Symbolically in Fig. 1, the electrical function of battery 12 is represented by the conventional symbol 14. Battery 12 thus will be understood to comprise the main power source which will power the stack and the applications load.

Other components selected for incorporation into the integrated power source of Fig. 1 include the following elements: a solar energy system 15 which comprises an array of conventional solar cells two of which 18 and 20 are shown connected by diodes 22 and 24, respectively, to a battery charge regulator 26, an optional battery life indicator 28, an RF charging circuit 30 connected between coil 31 and diode 33, and an internal applications load shown as consisting of a resistor 32. The representative solar cells 18 and 20 can be in rigid form or flexible form depending on the application requirement. As will be appreciated, solar energy system 15 converts solar energy to electrical energy and typically would

be expected to deliver electrical current to a battery, such as the battery 14.

5 The actual physical characteristics of integrated power source 10 may best be appreciated by reference to Fig. 2. The polymer battery 12, the solar cells 18 and 20, and the polymer semiconductor circuitry 17 comprising the regulator 26, the indicator 28, charging circuit 30, and applications load resistor 32 have previously been discussed in connection with the device shown in Fig. 1. Capping the device in direct abutting relationship with one side of the solar cells is a protective cover 34 transparent to solar radiation and having the primary function of protecting the solar cells from physical damage. Cover 34 may advantageously incorporate if desired an infrared filter in an effort to reduce to a minimum heat buildup in the integrated power source caused by infrared heating. Supporting the integrated power source 10 and in direct abutting relationship with one side of the polymer semiconductor circuitry 17 is a base structure material 36. The base material adds an optional foundation for supporting integrated power source 10 and it has, if desired, such optional uses as electrical isolation, electrical grounding, and antenna for the stack when required. Base material 36 equally can be a separate layer or be integrated with the layers above it.

25 From the description of the invention to this point, it will be appreciated that the integrated power source embodying the invention results in a self-contained, thin, lightweight, modular, easily portable, and renewable source of power with diverse application in such fields as telecommunications equipment, portable tools, portable PC's, vehicles, crafts, spacecraft, consumer electronics and toys. It will be evident that no separate enclosure or battery compartment is required since the source of electrical current readily is fed to polymer battery 12 from solar energy system 15. The capacitance, resistors, diodes and other electronic components are placed on the polymer substrate, or made part of the substrate to implement the charging circuit of battery 12.

Alternatively, the electronics components layer may be implemented by other technologies such as by adopting chip-on-board techniques. That is, interconnections can be expected to be traces on the substrate between the solar cells, charging circuits and battery 12 for electrical power flow between them. Being highly malleable, the integrated power source 10 has the ability to be adapted to multiple configurations thus being able to take the shape of any desired application housing. It thus has the flexibility to be molded across structural members like spacecraft tubing, spacecraft (such as side to bottom) panels, solar panels, spacecraft linkages, and propellant tanks. With prudent utilization, and periodic access to solar radiation, power exhaustion in all likelihood should never occur.

Referring now to Fig. 3(a), the integrated power source 10 is shown applied to a hand-held transceiver, generally designated 38, of a conventional cordless telephone system. In the side view of transceiver 38 as shown in Fig. 3(a), the transceiver incorporates protective cover 34, solar cells 18 and 20 layered under the cover, and polymer battery 12 not only shaped or molded to conform to the design of transceiver 38 but completely enveloping the transceiver except, as shown in front and back views 3(b) and 3(c), for necessary perforations which accommodate an antenna 40, viewing screen 42, and conventional push buttons 44. From the foregoing description, it will be understood that the mottled areas 12 as they appear in Figs. 3(a) and 3(b) represent the polymer battery 12 as a flexible polymer material that is either n or p-doped functioning either as cathode or anode material with the solar cells converting photons into charge carriers in the doped polymer material which will give rise to an electrical current. The casing of transceiver 38, in the example given, thus will be composed of the entire integrated power source itself, thereby dispensing with any underlying structural frame and disposing entirely of battery compartment or enclosure routinely encountered in contemporary and conventional remote communication systems.

The advantageous features of the invention described hereinabove thus appear in the assembly of a polymer battery which not only provides solar-converted electrical energy to an electronic unit but simultaneously serves as the structural casing or core of the electronic unit itself. Typical conventional interconnecting wires extending between the battery, a charging circuit, and a regulating circuit can be entirely eliminated since the present invention anticipates that polymer semiconductor circuitry 17 will consist of integrated circuits, discrete devices, memory devices, which in conjunction with the polymer battery powers an application load. By integrating a flexible and malleable polymer battery as the principal structural shell of a solar-powered electronic unit, power should never run out with prudent utilization, battery replacement per se becomes a thing of the past, and the resulting reduction in weight and volume effect important economic savings in application packaging design.

Considering Fig. 3(d) in detail, an alternative source of power to solar radiation is provided by an RF charging cradle 46 which is connected by means of a conventional power cord 48 to a 110-120v outlet (not shown). In operation, therefore, the choice exists of charging polymer battery 12 via either the RF charging circuitry through inductive coupling of energy from the charging cradle 46, noninvasively via coupling coil 31 which is integrated on the polymer battery, or by current output when the solar cells are exposed to solar radiation.

Turning now to a discussion of Fig. 4, the integrated power source 10 of Fig. 1 is laminated onto the structure of an automobile 50 for providing continuous power renewal during times when the vehicle is under exposure to solar radiation.

In Fig. 5, the integrated power source is shown applied to a lap top electronics unit 52 which incorporates polymer battery 12 as the shell or casing, thus eliminating the additional bulk of the battery compartment conventionally imposed by prior art structural enclosures to support the display panel and operating controls.

In the device shown in Fig. 6, a sun shield panel 60 is shown mounted on the rear window 62 of a vehicle 64. The polymer battery 12, solar cells 18-20, and various charging circuits are represented by the mottled area shown covering the window 62. Through the use of an integrated wireless transmitter and light emitting diodes (not shown) the panel 60 may provide emergency communication wireless calls for assistance and also a lighted display of messages in darkness and thereby transmit customized electronic distress signals regardless of lighting conditions. For this to occur, it will be appreciated that the panel will absorb light energy during the day to charge up the panel battery which can provide power during extended periods of darkness.

Considering now Fig. 7, the integrated power source 10 of Fig. 1 is applied to cover the roof 66 of a building 68 such as a dwelling, factory or the like. The integrated power source 10, of course, as shown in the inset, includes cover 34, solar cells 18-20, polymer battery 12, the polymer semiconductor circuitry 17, all mounted on the base structure material provided by the building 68. The roof top design, with proper industrial sizing and planning, anticipates obviating the need for a utility company power hook up in remote areas. Other benefits of the roof top incorporation of the integrated power source of the present invention include its use as an auxiliary power source for energy saving.

In the application of the invention embodiment shown in Fig. 8, signs 72 and 74 are supported by a roadside support 76 having posts 78 and 80 anchored to the ground and are equipped to deliver commandable electronic directional and or highway-related messages to vehicles passing in the vicinity of the signs. Rather than illuminate the signs during darkness by conventional means such as alternating current or standby emergency battery power, signs 72 and 74 both incorporate the integrated power source 10 described earlier in connection with Figs. 4-7. Accordingly, it will be understood from an examination of Fig. 9 that each sign 72 and 74 has a construction which not only is in accordance with the

invention, but has been described in detail in connection with the operation given for the embodiment shown in Fig. 2. Also, the integrated power source can be utilized to power remotely placed sensor and communications equipment in support of future intelligent highways.

The integrated power source of the present invention can also be designed to operate with a memory storage devices made up of optional dynamic random access memory (DRAM) and static random access memory (SRAM) that can be programmed for long term data retention which results in nonvolatility of the stored data. In addition to the two methods for charging the battery 12 described hereinabove, the present invention offers a third method utilizing a manually operated electrical generating charging device under emergency conditions such as might be encountered by prolonged periods of darkness or the absence of conventional wall outlet power. An integrated power source containing these features is shown in the block diagram of Fig. 10.

As shown in Fig. 10, a rechargeable battery 81 of the polymer type hereinabove described is under the control of a micro-controller generally designated 82 which contains conventional battery charging, discharging, and regulating circuits to accommodate a range of voltage outputs whose selection is based on the voltage demands of the system. Optionally, but not shown, micro-controller 82 may in addition contain circuitry well known in the art for protecting battery 81 against the damage from inadvertent reverse polarity. That is, the reverse polarity circuit may consist of semiconductors such as diodes which prevent damage to the circuit when the rechargeable battery is inadvertently connected in such a way that the positive and negative terminals are interchanged. Application electronics 84 may be considered to be the equivalent of the polymer semi-conductor circuitry 17 described in connection with the several applications shown in Figs. 4-9. Likewise, battery charge state display 86 is the equivalent of the battery life indicator 28 shown in Fig. 1 and the solar cells 88 and induction charger 90 have also been described in

depth in connection with Figs. 1 and 3, respectively.

Selection of the source of the current to be delivered to battery 81 is under the control of auto select charging unit 92 having a third input from miniature generator 94. Auto select charging unit 92 may be internally configured to accept electrical current for charging battery 81 from any one of the three sources, or from all three simultaneously. Generator 94 may assume various forms well known to those skilled in the art but, in the embodiment shown in Fig. 10, one form of miniature generator can be a hand-held generator that consists of a motor, a gear assembly, a flywheel, a one-way clutch and an input motion trigger. Movement of the input trigger will generate an amplified circular motion of the motor shaft through the gear assembly. When the motor shaft turns, it will generate a magnetic field through the motor coils. This magnetic field will then provide a potential voltage and current at the motor terminals that can be used for charging of the battery. The input motion can be a linear or a circular motion. A DRAMS/SRAMS memory module 96 optionally may be connected to battery 81 to store in digital form data concerning various operational characteristics of battery 81. Operational characteristics of the applications circuitry and data gathered from the applications circuit can also be stored in the non-volatile memory.

Fig. 11 shows another and somewhat more extensive arrangement of the integrated power source of the present invention which offers greater resistance to mechanical impact and protects against abrupt changes in atmospheric pressure. Referring now to Fig. 11, the integrated power source is made up of multiple layers of laminations arranged in a predetermined order inside to outside beginning with a battery charge state display 98 and ending with a protective transparent cover 100. Next of the electronic components in the order shown between the two outer laminations are optional DRAMS/SRAMS memory module 102, rechargeable battery 104, battery electronics 106, and an array of solar cells 108. Sandwiched between the solar cells 108 and battery electronics

106, between battery electronics 106 and battery 104, between battery 104 and optional DRAMS/SRAMS memory module 102, and between optimal DRAMS/SRAMS memory module 102 and battery charge state display 98 are layers of structural composite 110.

5 The presence of the structural composite layers 110 contributes to the overall rigidity of the integrated power source thus making it less vulnerable to mechanical impact and sudden pressure decompression especially in those applications where the integrated power source serves as the housing structure of
10 an operational device. It will be appreciated, of course, that the number of the composite layers 110 may be reduced, or the number kept the same and their thickness made a matter of adjustment, until the optimum value of structural rigidity of the integrated power source has been attained.

15 It will be understood that the invention is not limited to the embodiments described above, it being apparent to those skilled in the art that various changes and modifications can be made without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. An integrated power source comprising:

a thin film rechargeable battery, and

energy conversion means connected to said battery for delivering electrical energy to said battery.
2. An integrated power source according to claim 1, wherein said energy conversion means comprises an array of solar cells.
3. An integrated power source according to claim 1, wherein said energy conversion means is a RF charging unit.
4. An integrated power source comprising:

a thin film polymer battery, and

energy conversion means connected to said battery for delivering electrical energy to said battery.
5. An integrated power source according to claim 4, wherein said energy conversion means comprises an array of solar cells.
6. An integrated power source according to claim 4, wherein said energy conversion means is an RF charging unit.

7. An integrated power source comprising from inside outside:

- a. a base structure material;
- b. semiconductor circuitry for implementing power management functions;
- c. a polymer battery composed of an ionically conducting gel polymer electrode doped on one surface with a polymeric anode and doped on its opposing surface with a polymeric cathode;
- d. solar energy conversion means for delivering electrical current to said battery; and
- e. a cover protecting said energy conversion means transparent to solar radiation.

8. An integrated power source according to claim 7, wherein apart from said base structure material said inside to outside composition is highly malleable for adaptation to multiple structural configurations.

9. An integrated power source according to claim 7, wherein said semiconductor circuitry includes a RF charging circuit, means for regulating the charge delivered to said battery, and means for indicating the life status of said battery.

10. An integrated power source according to claim 7, wherein said energy conversion means comprises an array of solar cells.

11. A power source integrally formed on a base material having a particular physical configuration and comprising from inside to outside:

- a. a layer of semiconductor circuitry mounted on said base material for implementing power management functions;
- b. a polymer battery composed of an ionically conducting gel polymer electrode doped on one surface doped with a polymeric anode and doped on its opposing surface with a polymeric cathode;
- c. solar energy conversion means for delivering electrical current to said battery; and
- d. a transparent cover protecting said energy conversion means.

12. A power source according to claim 11, wherein said semiconductor circuitry includes a RF charging circuit, means for regulating the charge delivered to said battery, and means for indicating the life status of said battery.

13. A power source according to claim 11, wherein said solar energy conversion means comprises an array of solar cells.

14. A power source according to claim 11, wherein said inside to outside composition is highly malleable for adaptation to the physical configuration of said base material.

15. A power source according to claim 11, wherein said base material comprises the housing of a hand-held transceiver.

16. A power source according to claim 11, wherein said base material comprises the shell of a passenger vehicle.

17. A power source according to claim 11, wherein said base material comprises the case of a lap top electronic unit.

18. A power source according to claim 11, wherein said base material comprises the rear window of a passenger vehicle.

19. A power source according to claim 11, wherein said base material comprises the roof of a building.

20. A power source according to claim 11, wherein said base material comprises a roadside sign or components of the intelligent highway.

21. An integrated power source comprising laminations arranged from inside to outside:

- a. semiconductor circuitry for implementing power management functions;
- b. a polymer battery;
- c. solar energy conversion means for delivering electrical current to said battery;
- d. a transparent cover protecting said solar energy means; and
- e. a base structure material having a particular structural configuration; said layer of semiconductor circuitry being bonded to the body of said base structure material whereby the composite laminations of said semiconductor circuitry, battery, and conversion means assume the configuration of said base material.

22. An integrated power source of claim 21, wherein said solar energy conversion means comprises an array of solar cells.

23. An integrated power source having layers of laminations arranged in the following order and comprising:

a battery charge state display;

a DRAMS/SRAMS memory module;

a rechargeable battery;

battery electronics;

solar cells;

a cover for protecting said solar cells;

and a structural composite sandwiched between said solar cells and battery electronics, between said battery electronics and said rechargeable battery, between said rechargeable battery and said memory module, and between said memory module and said battery charge state display.

24. An integrated power source according to claim 1, wherein said battery is a thin film polymer battery.

25. An integrated power source comprising:
a rechargeable battery;

micro-controller means for regulating the electric current flow to said battery;

a plurality of sources of electrical current;

a selection unit connected between said micro-controller means and said plurality of sources of electrical current for selecting one of said sources of electrical current; and

means connected to said micro-controller means for indicating the charge state of said battery.

26. An integrated power source according to claim 25 including memory module means for storing in digital format data concerning various operational characteristics of said battery.

27. An integrated power source according to claim 25, wherein said battery is a thin film polymer battery.

28. An integrated power source according to claim 25, wherein one of said sources of electrical current is a hand-held generator.

AMENDED CLAIMS

[received by the International Bureau on 4 November 1996 (04.11.96);
original claims 4, 7, 11 and 21 amended; original claims 1-3 cancelled;
remaining claims unchanged (4 pages)]

4. An integrated power source comprising:

an all polymer battery, and

energy conversion means connected to said battery for
delivering electrical energy to said battery.

7. An integrated power source comprising:
 - a. a base structure material;
 - b. semiconductor circuitry for implementing power management functions;
 - c. an all polymer battery composed of an ionically conducting gel polymer electrode doped on one surface with a polymeric anode and doped on its opposing surface with a polymeric cathode;
 - d. solar energy conversion means for delivering electrical current to said battery; and
 - e. a cover protecting said energy conversion means transparent to solar radiation.

11. A power source integrally formed on a base material having a particular physical configuration comprising:

- a. a layer of semiconductor circuitry mounted on said base material for implementing power management functions;
- b. an all polymer battery composed of an ionically conducting gel polymer electrode doped on one surface with a polymeric anode and doped on its opposing surface with a polymeric cathode;
- c. solar energy conversion means for delivering electrical current to said battery; and
- d. a transparent cover protecting said energy conversion means.

21. An integrated power source comprising:
- a. semiconductor circuitry for implementing power management functions;
 - b. an all polymer battery;
 - c. solar energy conversion means for delivering electrical current to said battery;
 - d. a transparent cover protecting said solar energy means; and
 - e. a base structure material having a particular structural configuration; said layer of semiconductor circuitry being bonded to the body of said base structure material whereby the composite laminations of said semiconductor circuitry, battery, and conversion means assume the configuration of said base material.

STATEMENT UNDER ARTICLE 19(1)

In response to the International Search Report dated August 26, 1996, please amend the above-identified application as follows:

In the Claims:

Cancel claims 1, 2 and 3.

Claim 4, line 2, delete "a thin film" and substitute therefor -- an all --.

Claim 7 (amended). An integrated power source comprising [from inside outside]:

- a. a base structure material;
- b. semiconductor circuitry for implementing power management functions;
- c. an all polymer battery composed of an ionically conducting gel polymer electrode doped on one surface with a polymeric anode and doped on its opposing surface with a polymeric cathode;
- d. solar energy conversion means for delivering electrical current to said battery; and
- e. a cover protecting said energy conversion means transparent to solar radiation.

Claim 11 (amended). A power source integrally formed on a base material having a particular physical configuration [and] comprising [from inside to outside]:

- a. a layer of semiconductor circuitry mounted on said base material for implementing power management functions;
- b. an all polymer battery composed of an ionically conducting gel polymer electrode doped on one surface with a polymeric anode and doped on its opposing surface with a polymeric cathode;

- c. solar energy conversion means for delivering electrical current to said battery; and
- d. a transparent cover protecting said energy conversion means.

Claim 21 (amended). An integrated power source comprising [laminations arranged from inside to outside]:

- a. semiconductor circuitry for implementing power management functions;
- b. an all polymer battery;
- c. solar energy conversion means for delivering electrical current to said battery;
- d. a transparent cover protecting said solar energy means; and
- e. a base structure material having a particular structural configuration; said layer of semiconductor circuitry being bonded to the body of said base structure material whereby the composite laminations of said semiconductor circuitry, battery, and conversion means assume the configuration of said base material.

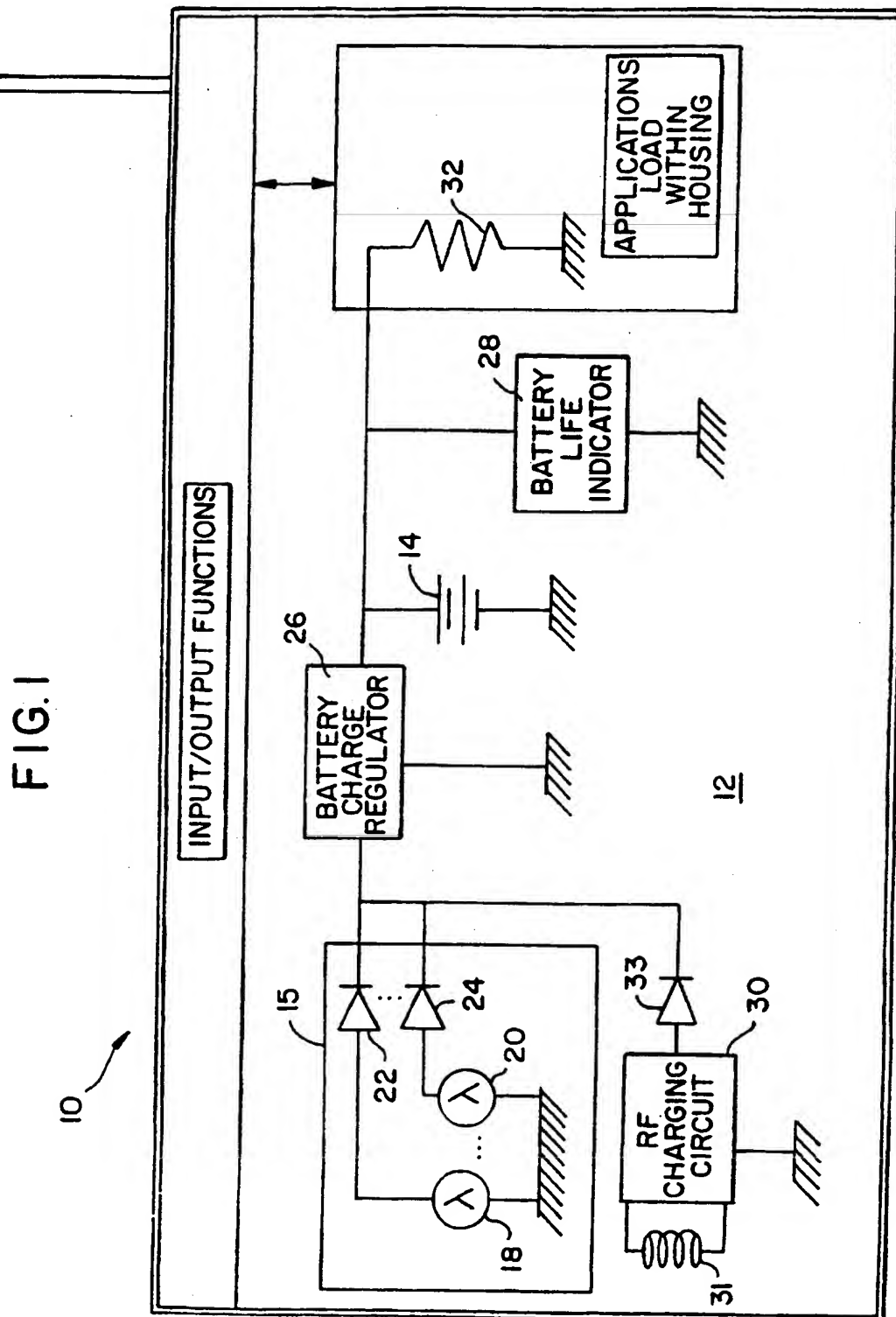
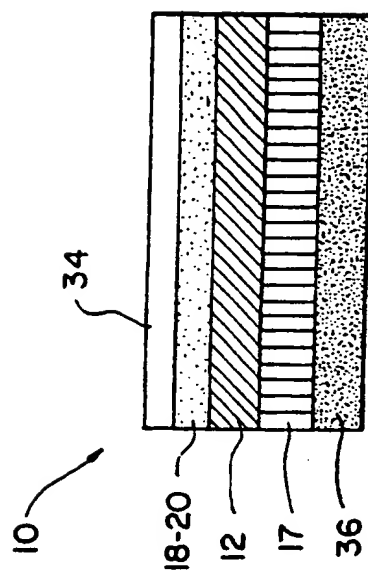


FIG. 2



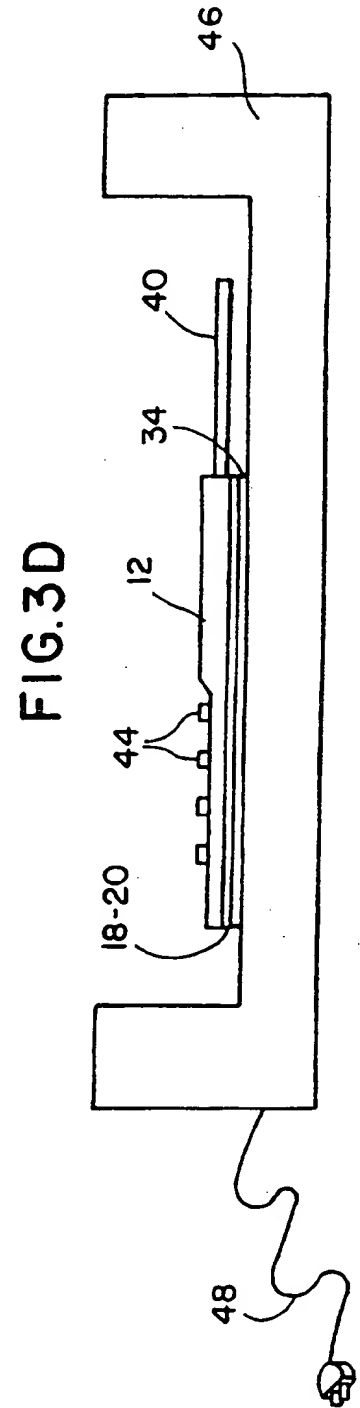
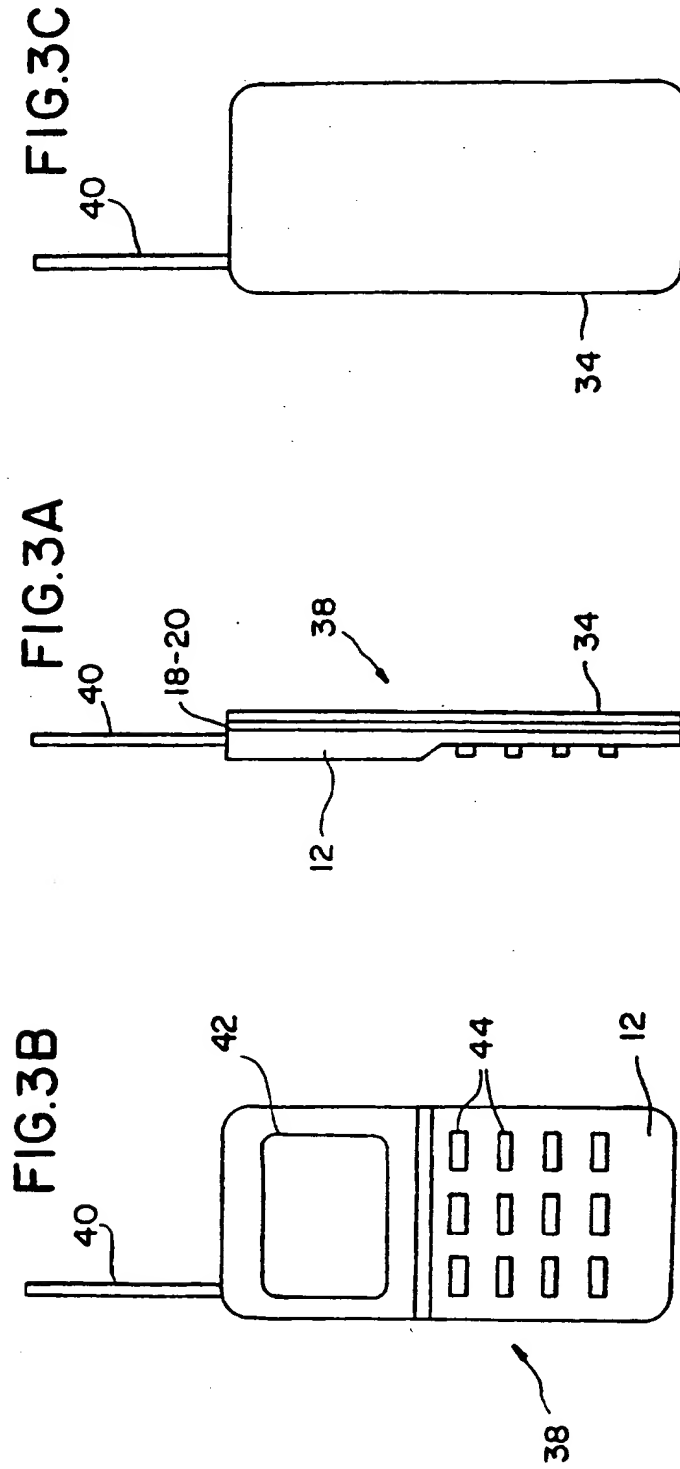


FIG.4A

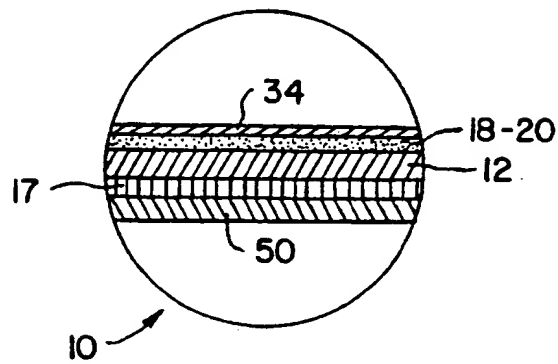


FIG.4B

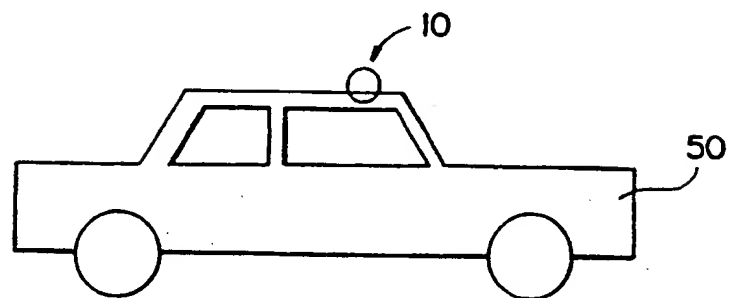


FIG.5

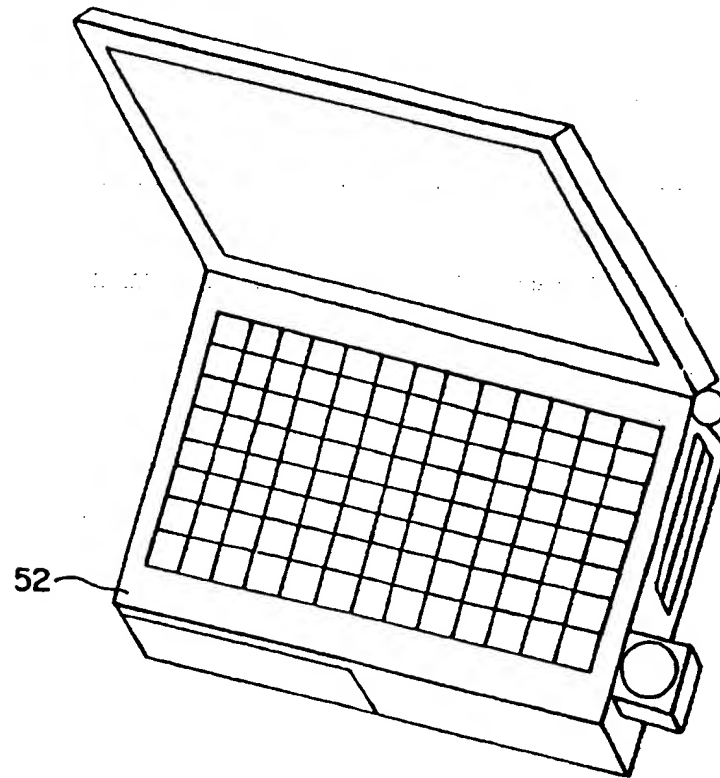


FIG.6

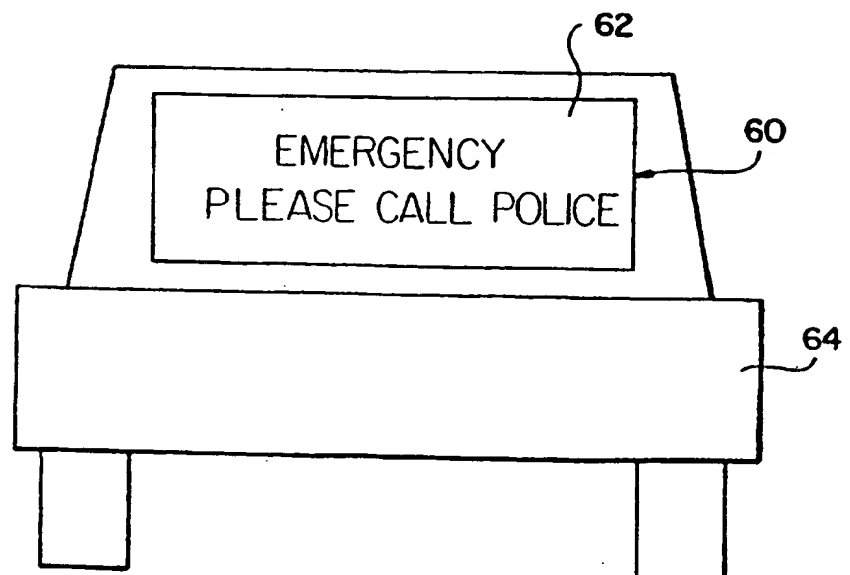


FIG. 7A

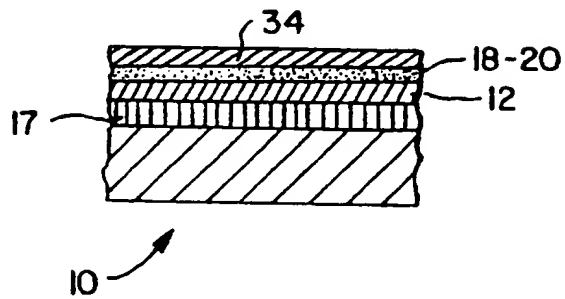
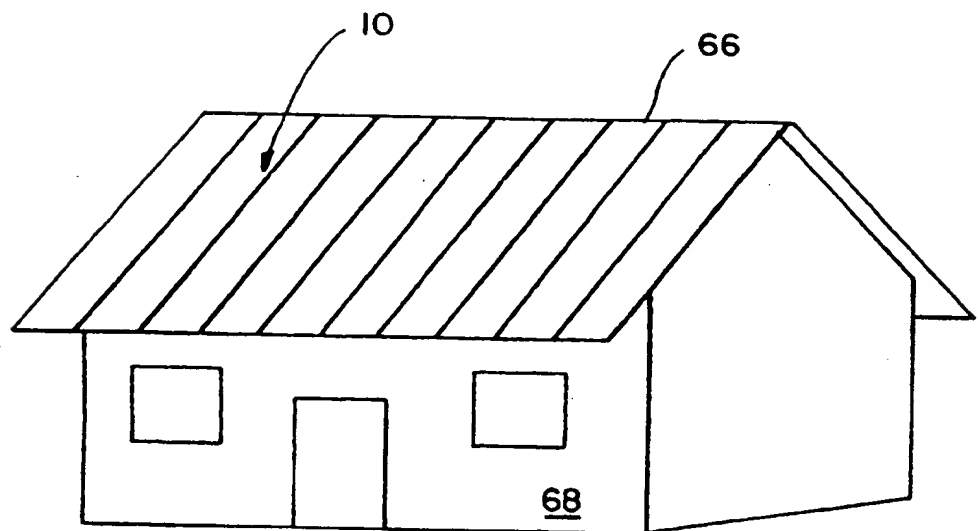


FIG. 7B



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FIG. 9

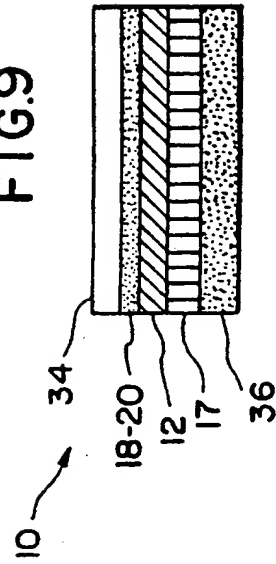


FIG. 8

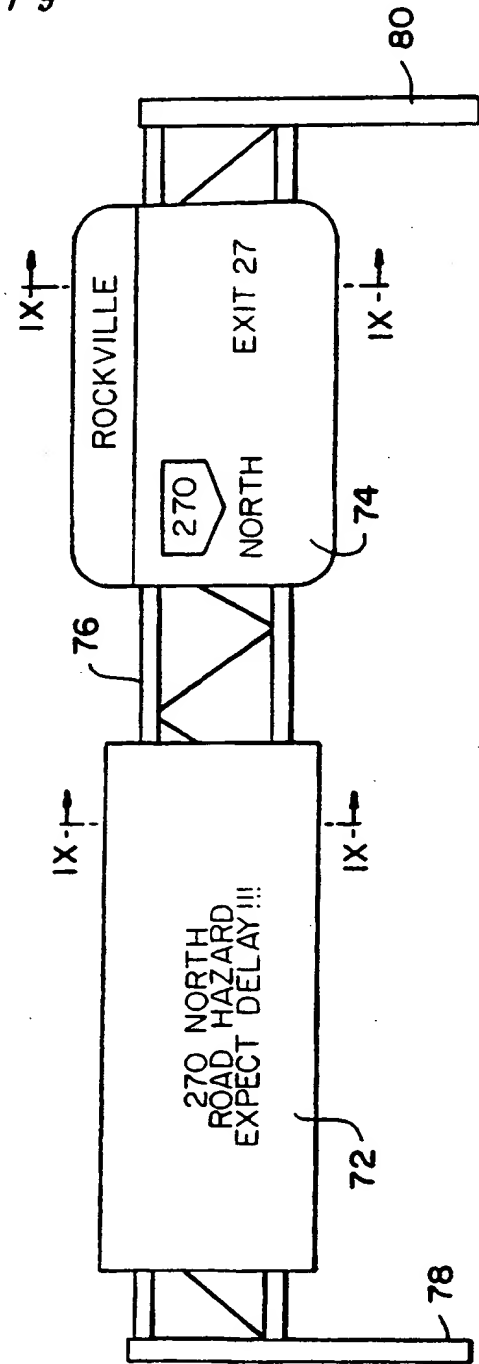


FIG. 10

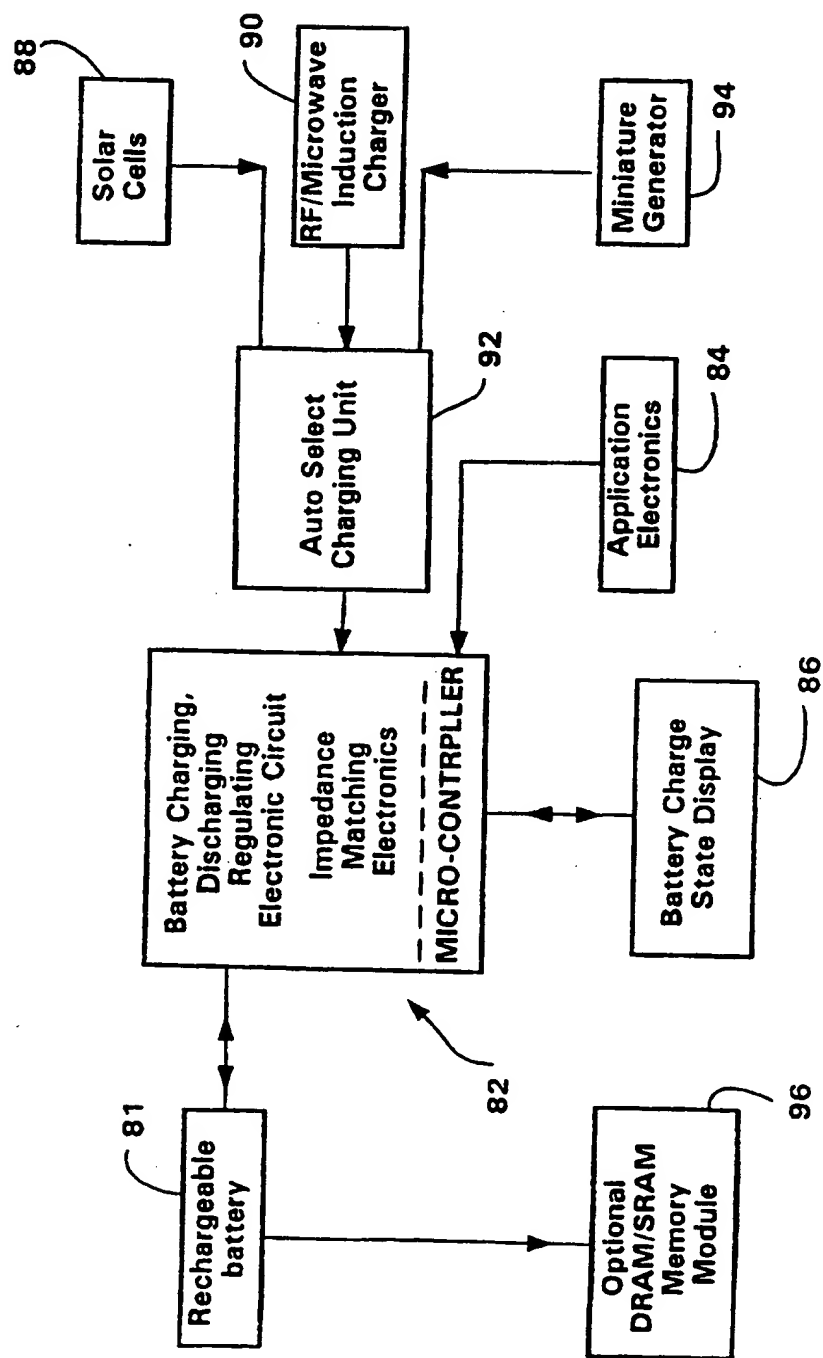
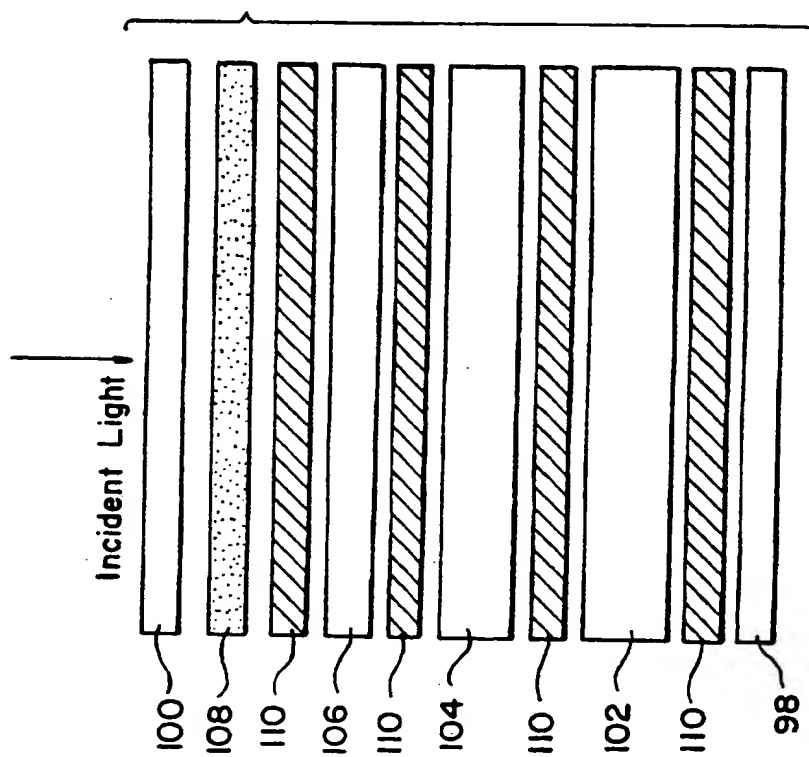


FIG. II



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/10822

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H01M 10/44; H05K 1/00

US CL : 320/2; 174/260; 429/193

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 320/2; 56; 174/260; 429/193; 361/765; 766; 257/82; 916; 307/18; 43

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, STN

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US, A , 5,147,985 (DUBRUCQ) 15 September 1992, (fig 1)	1, 2, 4, 5 ----- 3, 6-24, 27
X ----- Y	US, A, 5,338,625 (BATES ET AL.) 16 August 1994, figure 1	1, 2, 4, 5 ----- 3, 6-24
X ----- Y	US, A, 4,740,731 (LITTLE) 28 April 1988, figure 5	1, 2, 4, 5 ----- 3, 6-24
Y	US, A, 3,938,018 (DAHL) 10 February 1976, figure 1	3, 6

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search

31 JULY 1996

Date of mailing of the international search report

26 AUG 1996

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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,680,724 (SUGIYAMA ET AL.) 14 June 1994, figure 1	9, 12
Y	US, A, 5,325,041 (BRIGGS) 28 June 1994, figure 1, col. 5, line 66 - col. 6, line 12	25-28
Y	US, A, 5,162,720 (LAMBERT) 10 November 1992, col. 7, lines 4-9	25-28
Y	US, A, 4,360,860 (JOHNSON ET AL.) 23 November 1982, see abstract	28
A	US, A, 4,823,241 (TRATTNER) 18 April 1989, figure 1	15-20
A	US, A, 5,448,110 (TUTTLE ET AL.) 05 September 1995, figure 1	15-20
A	US, A, 4,833,726 (SHINODA ET AL.) 23 May 1989, figure 1	15-20
A	US, A, 4,955,203 (SUNDAR) 11 September 1990, figure 1	15-20
A	US, A, 4,744,430 (MCCOY) 17 May 1988, figure 3	15-20
A	US, A, 4,810,860 (SEKINE) 07 May 1989, figure 1	15-20
A	US, A, 5,433,259 (FALUDY) 18 July 1995, figure 2	15-20

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